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(71) Applicant

**BICC Public Limited Company**

**(Incorporated in the United Kingdom)**

**Devonshire House, Mayfair Place, London, W1X 5FH,  
United Kingdom**

(72) Inventors

**Christopher Simon Pegge**

**Stephen Thomas Spedding**

(74) Agent and/or Address for Service

**Edward Lewis Ross Gower**

**BICC Public Limited Company,**

**Patents & Licensing Department, Quantum House,  
Maylands Avenue, Hemel Hempstead, Hertfordshire,  
HP2 4SJ, United Kingdom**

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(56) Documents cited

**GB 2177231 A**

**GB 2164469 A**

**GB 2115172 A**

**GB 2074753 A**

**GB 2063502 A**

**US 5048922 A**

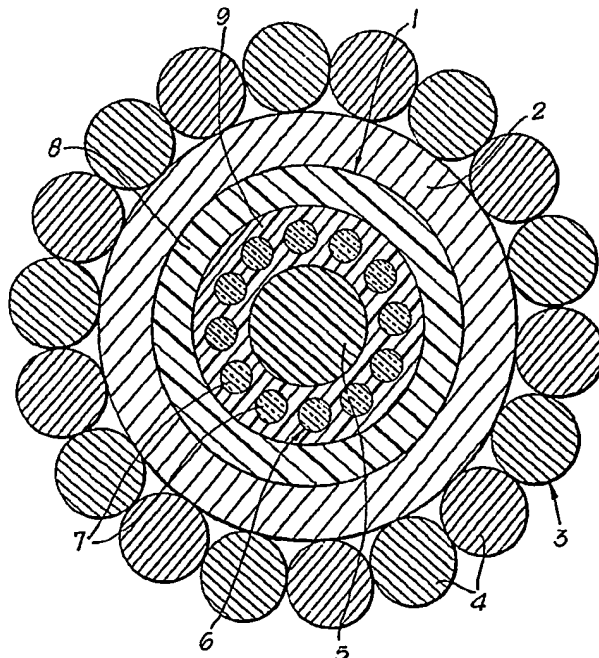
(58) Field of search

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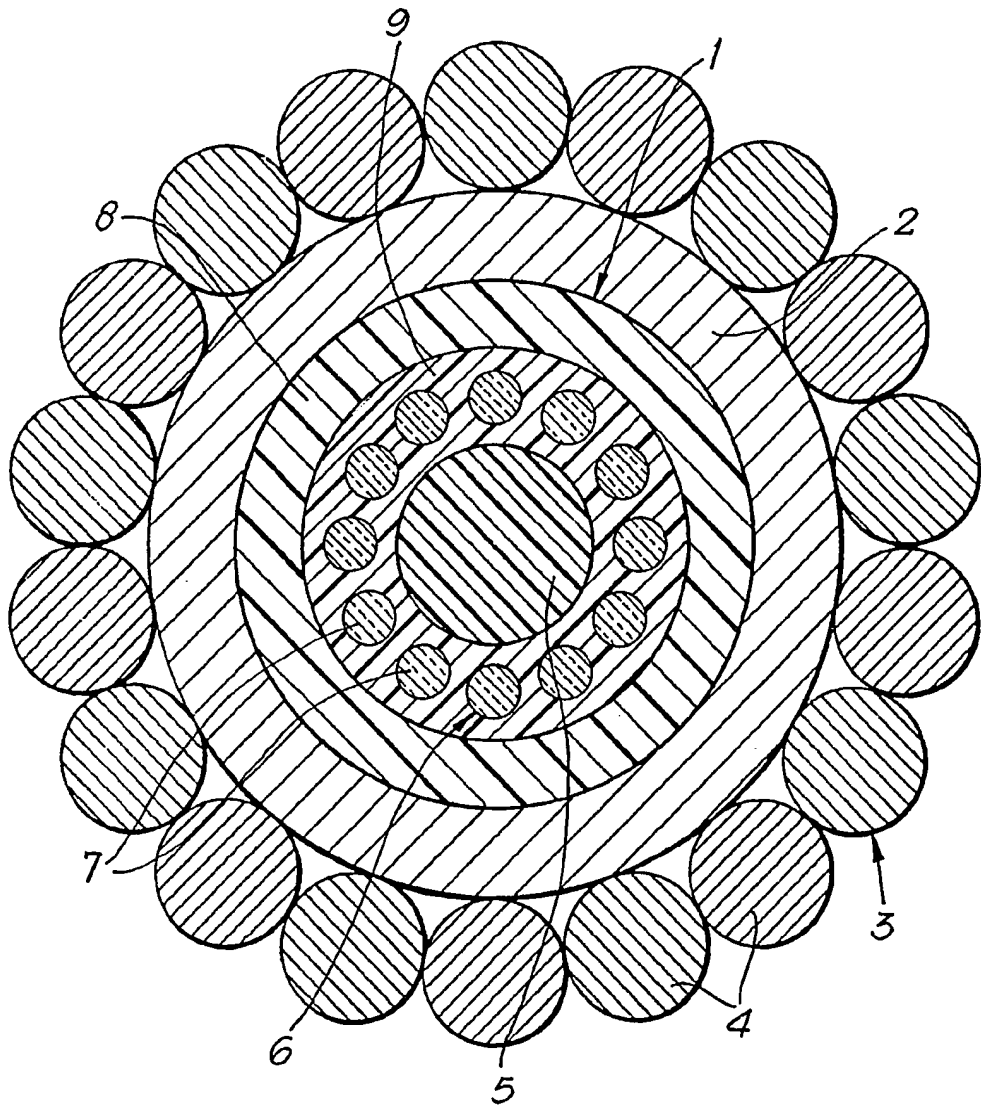
## (54) Composite overhead electric and optical fibre conductor

(57) A composite overhead electric and optical conductor comprises a circumferentially rigid central metal, e.g. aluminium or metal alloy tube 2 having tightly disposed in its bore throughout its length a flexible optical guide 1 and, surrounding the tube 2, at least one layer 3 of helically wound electrically conductive metal or metal alloy e.g. steel wires 4. The flexible optical guide 1 comprises a central, preferably non-metallic, tensile resistant strength member 5, a layer 6 of optical fibres 7 wound helically around the central member 5 and, surrounding the layer of optical fibres, an overall plastics sheath 8 of e.g. cross-linked polyethylene. The interstices between the optical fibres 7, between the fibres and the member 5 and between the fibres and the sheath 8 are filled with a cured resin e.g. photo-cured acrylic resin 9 so that the optical fibres are wholly encapsulated therein. The interstices between the optical fibres may be filled with a water-impermeable medium or accommodate water-swellaable elements. The optical fibres may be colour coded.



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AN IMPROVED COMPOSITE OVERHEAD ELECTRIC  
AND OPTICAL CONDUCTOR

This invention relates to overhead electric conductors of the kind which comprise one or more than one layer of helically wound elongate elements of electrically conductive metal or metal alloy and which are adapted to be freely suspended in long lengths from towers, pylons or other upstanding supports mutually spaced along the route of an overhead electric transmission or distribution system.

The invention is particularly concerned with overhead electric conductors of this kind which include at least one flexible optical guide consisting of or comprising at least one optical fibre for transmission of the ultra-violet, visible and infra-red regions of the electro-magnetic spectrum, which regions, for convenience, will hereinafter all be included in the generic term "light". One composite overhead electric optical conductor of this kind is the subject of our British Patent No: 1598438.

It has become the general practice to employ a composite overhead electric and optical conductor of the aforesaid kind as an earth conductor of an overhead electric transmission or distribution system and, because a composite overhead electric and optical conductor of this kind may be manufactured to have the same or approximately the same properties of sag and tension as those of conventional overhead earth conductors of substantially the same overall diameter,

it can be used to replace a conventional overhead earth conductor of an existing overhead electric transmission or distribution system thereby to provide a relatively inexpensive communication link between stations, substations and other locations along the route of the system and/or an optical communication system between populated areas between which the overhead electric transmission or distribution system extends.

With the rapid growth of communication services required, it is recognised that a composite overhead electric and optical conductor of the aforesaid kind of necessity will have to incorporate a greater number of optical fibres for the transmission of light signals than has hitherto been provided. Whilst increasing the number of optical fibres incorporated in an overhead electric conductor is not in itself a problem, it is desirable that an increase in optical fibre count of a composite overhead electric and optical conductor is achieved without effecting a substantial increase in the overall diameter, and hence weight, of the conductor. This is especially important where a composite overhead electric and optical conductor having a high optical fibre count is to be used to replace an overhead earth conductor of an existing overhead transmission or distribution system if the substantial expense of upgrading the towers, pylons or other upstanding supports of the system to accommodate a larger and heavier earth conductor is to be avoided.

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It is an object of the present invention to provide an improved composite overhead electric and optical conductor which can have a greater number of optical fibres than and substantially the same overall diameter as composite overhead electric and optical conductors hitherto proposed and used.

According to the invention, the improved composite overhead electric and optical conductor comprises a circumferentially rigid central core of metal or metal alloy having throughout its length a bore in which a flexible optical guide is substantially tightly disposed and, surrounding the central metal core, at least one layer of helically wound elongate elements of electrically conductive metal or metal alloy, which the flexible optical guide comprises a central elongate member of high tensile strength, at least one layer of optical fibres disposed around the central tensile-resistant member and, surrounding the layer or layers of optical fibres, an overall sheath of plastics material, the interstices between the optical fibres, between the fibres and the tensile-resistant member and between the fibres and the plastics sheath being filled with cured resin so that the optical fibres are wholly encapsulated therein.

The optical fibres of the or each layer preferably are wound helically around the central tensile-resistant member and, where two or more layers of helically wound optical fibres are present, the directions of lay of the

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helically wound optical fibres of adjacent layers may be of opposite hand to one another. In some instances, the direction of lay of the optical fibres of the or each layer may be reversed at spaced positions along the length of the flexible optical guide.

Preferably, to ensure that the improved composite overhead electric and optical conductor is capable of withstanding temperatures up to approximately 250°C with negligible risk of degradation of the optical fibres due to heat exposure, the cured resin within which the optical fibres are wholly encapsulated is a photo-cured acrylate resin and the overall sheath is of cross-linked polyethylene. Where the improved composite conductor is required to withstand temperatures substantially higher than 250°C, e.g. at least 300°C, preferably the overall sheath is made of a high temperature resistant thermoplastics material, e.g. a fluoropolymer; preferably, also, in these circumstances a layer of thermal insulating material underlies and/or overlies the overall plastics sheath to limit further risk of degradation of the optical fibres due to heat exposure. Suitable thermal insulating materials include silicone elastomers.

Each optical fibre of the or each layer preferably has a coating of a colour readily distinguishable from the colour of the coating of each other of the optical fibres of the layer.

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Preferably, each optical fibre of the improved composite overhead electric and optical conductor has been proof-tested to ensure that it is capable of withstanding any tensile force to which it is likely to be subjected whilst the composite conductor is in service and, in general, optical fibres currently available from Optical Fibres, Deeside, Clwyd are wholly suitable for use in the improved composite conductor, but where the improved composite conductor is to be used in an overhead electric transmission or distribution system where it is likely to be subjected to exceptionally severe conditions whilst it is in service, specially manufactured strain-resistant optical fibres may be employed.

The central elongate tensile-resistant member of the flexible optical guide of the improved composite conductor preferably is made of a non-metallic material of high tensile strength, a pultruded rod of resin bonded fibres of non-optical glass or other non-metallic tensile resistant material being preferred.

The circumferentially rigid central tubular metal core preferably is a tube of metal or metal alloy, which tube may be formed by extrusion or may have a welded seam, but in some circumstances it may be formed from an extrudate of approximately C-shaped transverse cross-section, the limbs of the extrudate being closed to form a seamed tube.

In manufacture of the flexible optical guide of the improved composite conductor of the present invention, preferably before the optical fibres are helically wound around the central tensile-resistant member, a circumferentially continuous bedding layer of curable resin is applied over the tensile resistant-member and, preferably also, after the optical fibres have been helically wound around the tensile-resistant member with the bedding layer thereon and the interstices between the optical fibres have been filled with a curable resin, a circumferentially continuous protective shell of curable resin is applied overall before extrusion of the plastics sheath. The curable resin of the bedding layer and of the protective shell may or may not be the same as the curable resin filling the interstices between the optical fibres.

By way of example, a flexible optical guide of the improved composite conductor having twelve optical fibres helically wound in a single layer around the central tensile-resistant member has an overall diameter which is less than half that of a comparable flexible optical guide of composite conductors hitherto proposed and used, as a consequence of which the improved composite conductor has an overall diameter which can be substantially less than that of most known comparable composite conductors.

Furthermore, an improved composite conductor having an exceptionally high optical fibre count, e.g. forty-eight optical fibres, can comprise two or more flexible optical guides of the improved composite conductor hereinbefore described helically laid up together and substantially tightly disposed in the bore of the circumferentially rigid tubular central core of metal or metal alloy, the interstices between the assembled flexible optical guides being filled with a water-impermeable medium or accommodating water-swellaable elements throughout the length of the composite conductor. For example, an improved composite conductor of the present invention comprising four flexible optical guides helically laid up together, each having twelve helically wound optical fibres, will have an overall diameter no greater than that of comparable composite overhead conductors hitherto proposed and used having only twenty-four optical fibres.

The invention is further illustrated by a description, by way of example, of a preferred composite overhead electric and optical conductor with reference to the accompanying drawing which shows a transverse cross-sectional view of the composite conductor, drawn on an enlarged scale.

Referring to the drawing, the preferred composite overhead electric and optical conductor comprises a circumferentially rigid central aluminium tube 2 having

tightly disposed in its bore throughout its length a flexible optical guide 1 and, surrounding the aluminium tube, a layer 3 of helically wound steel wires 4. The flexible optical guide 1 comprises a central pultruded rod 5 of resin bonded fibres of high tensile strength, a layer 6 of twelve optical fibres 7 wound helically around the central pultruded rod and, surrounding the layer of optical fibres, an overall sheath 8 of cross-linked polyethylene. The interstices between the optical fibres 7, between the fibres and the central pultruded rod 5 and between the fibres and the overall sheath 8 are filled with photo-cured acrylate resin 9 so that the optical fibres are wholly encapsulated therein.

The preferred composite overhead electric and optical conductor illustrated in the accompanying drawing and incorporating twelve optical fibres 7 has substantially the same overall diameter as composite overhead electric and optical conductors hitherto proposed and used and incorporating only a few optical fibres.

CLAIMS

1. A composite overhead electric and optical conductor comprising a circumferentially rigid central core of metal or metal alloy having throughout its length a bore in which a flexible optical guide is substantially tightly disposed and, surrounding the central metal core, at least one layer of helically wound elongate elements of electrically conductive metal or metal alloy, wherein the flexible optical guide comprises a central elongate member of high tensile strength, at least one layer of optical fibres disposed around the central tensile-resistant member and, surrounding the layer or layers of optical fibres, an overall sheath of plastics material, the interstices between the optical fibres, between the fibres and the tensile-resistant member and between the fibres and the plastics sheath being filled with cured resin so that the optical fibres are wholly encapsulated therein.

2. A composite overhead electric and optical conductor as claimed in Claim 1, wherein the optical fibres of the or each layer are wound helically around the central tensile-resistant member of the flexible optical guide.

3. A composite overhead electric and optical conductor as claimed in Claim 2 in which two or more layers of optical fibres are helically wound around the central tensile-resistant member of the flexible optical

guide, wherein the directions of lay of the helically wound optical fibres of adjacent layers are of opposite hand to one another.

4. A composite overhead electric and optical conductor as claimed in Claim 2 or 3, wherein the direction of lay of the optical fibres of the or each layer is reversed at spaced positions along the length of the flexible optical guide.

5. A composite overhead electric and optical conductor as claimed in any one of the preceding Claims, wherein the cured resin within which the optical fibres of the flexible optical guide are wholly encapsulated is a photo-cured acrylic resin and the overall sheath is of cross-linked polyethylene.

6. A composite overhead electric and optical conductor as claimed in any one of Claims 1 to 4, wherein the cured resin within which the optical fibres of the flexible optical guide are wholly encapsulated is a photo-cured acrylic resin and the overall sheath is of a fluoropolymer.

7. A composite overhead electric and optical conductor as claimed in Claim 6, wherein a layer of thermal insulating material underlies and/or overlies the overall sheath.

8. A composite overhead electric and optical conductor as claimed in Claim 7, wherein the thermal insulating material is a silicone elastomer.

9. A composite overhead electric and optical conductor as claimed in any one of the preceding Claims, wherein the central elongate tensile-resistant member of the flexible optical guide is made of a non-metallic material of high tensile strength.

10. A composite overhead electric and optical conductor as claimed in Claim 9, wherein the central elongate tensile-resistant member of the flexible optical guide is a pultruded rod of resin bonded fibres of non-optical glass or other non-metallic tensile resistant material.

11. A composite overhead electric and optical conductor as claimed in any one of the preceding Claims, wherein each optical fibre of the or each layer has a coating of a colour readily distinguishable from the colour of the coating of each other of the optical fibres of the layer.

12. A composite overhead electric and optical conductor as claimed in any one of the preceding Claims, wherein each optical fibre has been proof tested.

13. A composite overhead electric conductor as claimed in any one of the preceding Claims, wherein the circumferentially rigid central core of metal or metal alloy is an extruded tube or a tube having a welded seam.

14. A composite overhead electric and optical conductor as claimed in any one of the preceding Claims,

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wherein the central tensile-resistant member of the flexible optical guide is immediately surrounded by a circumferentially continuous bedding layer of a cured resin different to that of the cured resin in which the optical fibres are wholly encapsulated and a protective shell of a cured resin different to that in which the optical fibres are wholly encapsulated immediately underlies the overall sheath of the flexible optical guide.

15. A composite overhead electric and optical conductor comprising a circumferentially rigid central core of metal or metal alloy having throughout its length a bore in which two or more flexible optical guides are helically laid up together and substantially tightly disposed and, surrounding the central metal core, at least one layer of helically wound elongate elements of electrically conductive metal or metal alloy, wherein each flexible optical guide comprises a central elongate member of high tensile strength, at least one layer of optical fibres disposed around the central tensile-resistant member and, surrounding the layer or layers of optical fibres, an overall sheath of plastics material, the interstices between the optical fibres, between the fibres and the tensile-resistant member and between the fibres and the plastics sheath being filled with cured resin so that the optical fibres are wholly encapsulated therein, and wherein the

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interstices between the assembled optical guides are filled with a water-impermeable medium or accommodate water-swellable elements throughout the length of the composite conductor.

16. A composite overhead electric and optical conductor substantially as hereinbefore described with reference to and as shown in the accompanying drawing.

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**Patents Act 1977**  
**Examiner's report to the Comptroller under**  
**Section 17 (The Search Report)**

Application Number

GB 9225801.1

**Relevant Technical fields**

(i) UK Cl (Edition K ) G2J (JGCA1)

(ii) Int Cl (Edition 5 ) G02B, H01B

**Search Examiner**

MR C J ROSS

**Databases (see over)**

(i) UK Patent Office

(ii)

**Date of Search**

22 FEBRUARY 1993

Documents considered relevant following a search in respect of claims 1-16

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
X	GB 2177231 A (FUJIKURA)	1 AT LEAST
X	GB 2164469 A (STC) see especially page 2 line 3 on, and page 3 line 9 on	1,15 AT LEAST
X	GB 2115172 A (STC)	1,15 AT LEAST
X	GB 2074753 A (PHILIPS) see especially Figure 1	1,15 AT LEAST
X	GB 2063502 A (STC) see especially Figures 1,2	1,15 AT LEAST
X	US 5048922 (KDDKK) see especially Figures 1,5	1,15 AT LEAST

Category	Identity of document and relevant passages	Relevant to claim(s)

### Categories of documents

**X:** Document indicating lack of novelty or of inventive step.

**Y:** Document indicating lack of inventive step if combined with one or more other documents of the same category.

**A:** Document indicating technological background and/or state of the art.

**P:** Document published on or after the declared priority date but before the filing date of the present application.

**E:** Patent document published on or after, but with priority date earlier than, the filing date of the present application.

**&:** Member of the same patent family, corresponding document.

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